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Can low-level 50/60 Hz electric and magnetic fields cause biological effects?

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Some epidemiological studies have suggested that exposure to ambient, low-level 50/60 Hz electric and magnetic fields (EMFs) increases risk of disease. Whether this association has a causal basis depends in part on whether the electrical, chemical and mechanical "signals" induced within living cells by ambient EMFs are detectable in the complex milieu of voltages, currents and forces present within the living organism. Magnetic responsiveness has been found in some animals and bacteria; aquatic animals (e.g. sharks and rays) can sense weak electric fields. We outline the physics of several mechanisms by which EMFs may interact: (1) Energy transfer by acceleration of ions and charged proteins modifies cell membranes and receptor proteins; however, EMF energies are far below those typical of biomolecules in the cell. (2) Electric fields induced inside the body exert force on electric charges and electric moments; however, these forces are considerably smaller than typical biological forces. (3) The magnetic moments of ferromagnetic particles and free radical molecules interact with magnetic fields, but magnetic-moment sensory cells have not been found in humans, and modification of radical recombination rates by EMFs in a biological system is highly problematic. (4) Resonant interactions involve EMFs driving vibrational or orbital transitions in ion-biomolecule complexes; these mechanisms conflict with accepted physics, and many experimental tests have not found the predicted effects. (5) Temporal averaging or spatial summation can improve the ratio of "signal" to "noise" in any system, but this "mechanism" requires biological structures and neural processes having the necessary capabilities of EMF detection and temporal averaging that have not been found in humans. In summary, biological effects in humans due to extremely low-frequency EMFs of the order of those found in residential environments [< or = 2 microT (< or = 20 mG)] are

implausible based on current understanding of physics and biology. Biological effects in humans at higher fields [> 10 microT (> 100 mG)] might reach plausibility as a result of time-averaging in combination with a magnetic-moment transduction mechanism; but even here, neither specialized EMF transduction structures nor appropriate averaging networks have been demonstrated. The bypothesis that the epidemiological associations observed between 50/60 Hz EMFs and disease reflect a causal relationship is not supported by what is known about mechanisms.

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